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The Additional Information Content of Quarterly Earnings Reports: Intertemporal Disaggregation

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The Additional Information Content of Quarterly
Earnings Reports: Intertemporal Disaggregation

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ABSTRACT

In this paper we attempt to assess the amount of additional information contained in quarterly corporate earnings figures compared with annual earnings totals. Our approach is to consider the use of both quarterly and annual earnings streams in the prediction of the next annual earnings value, using univariate time series models. Any improvement in forecast quality obtained through the use of quarterly rather than annual figures reflects an additional information content in the former.

Our results indicate that, given the firm and parameters of the model generating the earnings series, the prediction error variance based on the annual figures will be 15-21% higher on average than when quarterly data is available in the case where no additional quarterly figures have been reported since the last annual total. However, if the annual model must be estimated from just a few years of annual data, the extent of this inflation increases to 35-60%. In subsequent time periods, as additional quarterly earnings figures become available, the gains from their use in predicting the next annual total increase substantially.

1. Introduction

In this paper we attempt to assess the amount of additional information contained in quarterly corporate earnings figures compared with annual earnings totals. Our approach is to consider the use of both quarterly and annual earnings streams in the prediction of the next annual earnings value, using univariate time series models. Any improvement in forecast quality obtained through the use of quarterly rather than annual figures reflects an additional information content in the former.

An immediate difficulty encountered in this approach is that the time series models generally fitted in the accounting literature to quarterly earnings figures do not, on aggregation, lead to the simple models typically used for annual earnings. We examine this aggregation problem in section 2 of the paper.

In section 3 of the paper we present empirical results for 267 firms. Forecasts of the next annual earnings figure, derived from both quarterly and annual earnings streams, are compared when 0, 1, 2, and 3 additional quarterly values are available since the last annual total. In the first of these cases, any gains from using the quarterly values reflect only the "disaggregation effect" produced by an increased frequency of reporting. In subsequent quarters, an increasing amount of information about the next annual earnings total will be available, and this will presumably be reflected in the increased precision of forecasts of that total.

2. Annual and Quarterly Time Series Models

Quarterly time series of corporate earnings per share have frequently been modelled through two "premier models":

(i) Griffin [1977] and Watts [1975] proposed the model

$$(1-B)(1-B^4)X_t = (1-\theta B)(1-\theta B^4)a_t \quad (1)$$

where X_t denotes quarterly earnings per share, a_t is a zero-mean purely random process, and B is a back-shift operator on the index of the time series, defined so that $B^j X_t \equiv X_{t-j}$.

(ii) Brown and Rozeff [1979] suggested the model

$$(1-\phi B)(1-B^4)X_t = (1-\theta B^4)a_t \quad (2)$$

Also Foster [1977] suggested a model which is the special case of (2) with θ equal to zero.¹

These two models have proved successful in the prediction of future values of corporate earnings. For example, Collins and Hopwood [1980] found that, on the average, they performed as well as a full analysis along the lines of Box and Jenkins [1970].

Now, when considering annual totals for corporate earnings per share, there appears to be near unanimity in favor of the random walk model

$$(1-B)Y_t = \varepsilon_t$$

where Y_t denotes non-overlapping annual earnings aggregates, and ε_t is a purely random annual process. For example, Albrecht et al. [1977]

and Watts and Leftwich [1977] found that a full Box-Jenkins analysis did not, on the average, produce more accurate forecasts than the simple random walk model.

Unfortunately, however, neither of the premier models, (1) and (2), implies the random walk model on aggregation. In fact, specializing results of Brewer [1973], it can be shown that, if the quarterly process is generated by the Griffin and Watts model, the appropriate model for the annual totals is the ARIMA (0,2,2) model

$$(1-B)^2 Y_t = (1-\theta_1^* B - \theta_2^* B^2) \varepsilon_t$$

where θ_1^* and θ_2^* are functions of θ and Θ in (1). Further, if the quarterly process is generated by the Brown and Rozeff model (2), the model for the annual totals is the ARIMA (1,1,2) model

$$(1-\phi^4 B)(1-B) Y_t = (1-\theta_1^* B - \theta_2^* B^2) \varepsilon_t$$

where θ_1^* and θ_2^* depend on ϕ and Θ in (2). Further details are given in the appendix.

Of course, for specific parametrizations of the quarterly models, the implied models for the annual totals may in fact not differ too much from the random walk models, and, for the kind of sample sizes found in practice, could often be observationally indistinguishable.

Now, for any given quarterly model, it is straightforward to calculate the theoretical error variance for forecasts of the next annual total, based on the available quarterly data. Moreover, the quarterly model can be used to derive the corresponding annual model, from which can be calculated the error variance for forecasts based only on the

available annual data. In this way we can assess theoretically the gains to prediction from using the disaggregated information. In the next section we report results of this kind for quarterly models fitted to 267 quarterly series of corporate earnings.

3. Some Empirical Results

For any quarterly time series model of the form (1) or (2), the specific model parameters will determine the coefficients of the corresponding annual model and hence the relative quality of forecasts based on quarterly and annual earnings streams. In order to get an estimate of the likely gains from disaggregation, we fitted, by maximum likelihood, the two quarterly models to 267 (COMPUSTAT) earnings series, each containing 48 to 64 observations (5 years).² For each series the fitted quarterly models were used to derive the coefficients of the corresponding annual models. The theoretical error variances for predictions of the next annual total were then calculated. For the quarterly models, we considered four cases--where 0, 1, 2, and 3 quarterly figures had been reported since the last available annual total. The averages of the ratios of forecast error variances are shown in Table 1.³ It can be seen from that table that, when no additional quarterly information is available, there is nevertheless a gain in using quarterly rather than annual earnings per share in the prediction of the next annual total. On average the error variance from the annual figures exceeds that from the quarterly values by 15% under the Brown-Rozeff model and 21% under the Griffin-Watts model. As is to be expected, these gains increase substantially as additional quarterly observations become available.

Table 1: Average over 267 Earnings Series of Ratio of Forecast Error Variance from Annual Earnings Stream to Forecast Error Variance for Quarterly Earnings Stream for Prediction of the Next Annual Earnings Per Share Value

<u>Quarterly Model</u>	<u>Number of Quarterly Observations Since Last Annual Total</u>			
	<u>0</u>	<u>1</u>	<u>2</u>	<u>3</u>
Griffin-Watts	1.21	2.39	5.82	23.43
Brown-Rozeff	1.15	2.02	4.47	17.38

The results reported in Table 1 concern theoretical forecast error variance ratios, based on the assumption that the quarterly models are correctly specified and their parameters known. In order to obtain further empirical evidence, we calculated forecasts and compared them with actual outcomes over the 5 years of hold-out data. Given the estimated models, the calculation of forecasts based on quarterly earnings is straightforward. In order to compute forecasts based only on past annual earnings figures we considered three possibilities, denoted as follows:

- (a) Annual from Quarterly: Here we used the estimated coefficients from the quarterly models to derive estimates of the parameters of the corresponding annual models, which were then used to compute forecasts. Thus, although these forecasts used only the annual totals, the parameters of the forecast function were derived using information in the quarterly series.
- (b) Annual Estimated: In this case the annual models implied by the two quarterly premier models were fitted to the annual data, using maximum likelihood. Since the amount of data available for estimation is very sparse, one might suspect that any advantage, in terms of forecast accuracy, resulting from superior model specification could be outweighed by imprecision in the parameter estimates.
- (c) Random Walk: Finally, we derived annual forecasts from the simple random walk model, since this is the most commonly used in practice.

The averages of the ratios of post-sample forecast mean squared errors over the 267 series are shown in Table 2.⁴ For the case where no additional quarterly figures have become available since the last reported annual total, the empirical results for the "annual from quarterly" forecasts are remarkably close to the theoretical results in Table 1. The additional imprecision for the other two annual forecasts results respectively from sampling variability in the parameter estimates of the annual model and the inappropriateness of the random walk specification. As the number of additional quarterly figures available increases, the realized empirical gains from using the quarterly earnings stream to generate forecasts becomes a smaller fraction of the theoretical gains reported in Table 1. (Nevertheless, these gains remain very substantial.) This finding would be consistent with the hypothesis that reported figures for quarterly earnings per share are relatively less accurate than the reported annual figures.

4. Summary

In this note we have attempted to measure the additional information content in quarterly as opposed to annual values for corporate earnings per share. Our approach has been to consider the problem of predicting, using univariate time series models, the next annual earnings figure, based on both quarterly and annual earnings streams.

Our results indicate that, given the firm and parameters of the model generating the earnings series, the prediction error variance based on the annual figures will be 15-21% higher on average than when quarterly data is available in the case where no additional quarterly

Table 2: Average over 267 Earnings Series of Ratio of Post-Sample Mean Squared Error of Forecast from Annual Earnings Stream to Post-Sample Mean Squared Error of Forecast from Quarterly Earnings Stream for Prediction of the Next Annual Earnings Per Share Value

<u>Method for Annual Forecasts</u>	<u>Number of Quarterly Observations Since Last Annual Total</u>			
	<u>0</u>	<u>1</u>	<u>2</u>	<u>3</u>
<u>Griffin-Watts Model</u>				
Annual from Quarterly	1.18	1.51	2.89	9.61
Annual Estimated	1.60	2.01	3.74	12.21
Random Walk	1.97	1.87	2.80	8.54
<u>Brown-Rozeff Model</u>				
Annual from Quarterly	1.17	1.52	2.38	7.25
Annual Estimated	1.35	1.69	2.66	7.91
Random Walk	1.44	2.11	2.50	7.30

figures have been reported since the last annual total. However, if the annual model must be estimated from just a few years of annual data, the extent of this inflation increases to 35-60%. In subsequent time periods, as additional quarterly earnings figures become available, the gains from their use in predicting the next annual total increase substantially.

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APPENDIX

In this appendix we derive the annual models corresponding to the quarterly premier models of Griffin and Watts and Brown and Rozeff.

Let X_t denote the quarterly time series and Y_t the corresponding series of non-overlapping annual aggregates. In writing quarterly models the subscript t will relate to periods of one quarter, while for annual models it will relate to periods of one years. Similarly, the back-shift operator B will apply to quarters and years in the respective models.

The Griffin and Watts model is

$$(1-B)(1-B^4)X_t = (1-\theta B)(1-\theta B^4)a_t$$

To derive a model for the annual totals, multiply through this equation by $(1+B+B^2+B^3)^2$, giving

$$(1-B^4)^2(1+B+B^2+B^3)X_t = (1+B+B^2+B^3)^2(1-\theta B)(1-\theta B^4)a_t \quad (1)$$

The right hand side of this equation has autocorrelations which are zero beyond the eleventh. Hence aggregating to annual totals it follows that the appropriate model is

$$(1-B)^2Y_t = (1-\theta_1^*B-\theta_2^*B^2)\varepsilon_t$$

where ε_t is purely random. Following from (1), θ_1^* and θ_2^* can be found by setting

$$u_t = (1-\theta_1^*B-\theta_2^*B^2)\varepsilon_t$$

and

$$v_t = (1+B+B^2+B^3)^2(1-\theta B)(1-\theta B^4)a_t$$

we then have

$$\text{corr.}(u_t, u_{t-j}) = \text{corr.}(v_t, v_{t-4j}) \quad (j=1,2)$$

Given θ and Θ , the right hand side of these equations is readily calculated. Hence θ_1^* and θ_2^* follow from the solution of a pair of non-linear equations.

Similarly, the Brown and Rozeff model is

$$(1-\phi B)(1-B^4)X_t = (1-\Theta B^4)a_t$$

Multiplying through this equation by $(1+\phi B+\phi^2 B^2+\phi^3 B^3)(1+B+B^2+B^3)$ it then follows, in the same manner as above, that the annual totals follow the model

$$(1-\phi^4 B)(1-B)Y_t = (1-\theta_1^* B-\theta_2^* B^2)\varepsilon_t$$

where θ_1^* and θ_2^* are found by setting

$$u_t = (1-\theta_1^* B-\theta_2^* B^2)\varepsilon_t$$

$$v_t = (1+\phi B+\phi^2 B^2+\phi^3 B^3)(1+B+B^2+B^3)(1-\Theta B^4)a_t$$

and solving the pair of non-linear equations

$$\text{corr.}(u_t, u_{t-j}) = \text{corr.}(v_t, v_{t-4j}) \quad (j=1,2)$$

Notes

¹Foster also had a constant in his model, but Brown and Rozeff [1979, p. 80] gave extensive evidence that this parameter does not improve the model.

²In all cases, the data began in the first quarter of 1962.

³The ratio for each firm was calculated as

$$\frac{\sum_{j=1}^5 S_{A_j}^2}{\sum_{j=1}^5 S_{Q_j}^2}$$

$S_{A_j}^2$ = error variance for derived annual model for year j

$S_{Q_j}^2$ = error variance for derived sum of quarterly forecasts for year j.

⁴The ratio of forecast errors for each firm was calculated as

$$\frac{\sum_{j=1}^5 (F_{A_j} - \text{Actual } j)^2}{\sum_{j=1}^5 (F_{Q_j} - \text{Actual } j)^2}$$

F_{A_j} = forecast from appropriate (annual from quarterly, annual estimated, or random walk) annual model for year j

F_{Q_j} = forecast from summary quarterly forecasts for year j.

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